Exercise 1: Market Research of the Space Industry

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The space industry has long been characterized by its reliance on high-reliability (HiRel) components and strict qualification processes, to ensure mission success in harsh space environments. Historically, Europe - and France specifically - has depended on US-manufactured space-grade components, which has limited its strategic autonomy. France has, over the years, invested in an independent space policy with CNES (Centre National d'Études Spatiales) and the Ariane program, which has put it in a dominant position in Europe's market. However, with New Space, the industry is radically changing. Unlike traditional space programs that prioritize extreme reliability and long mission lifespans, New Space is all about cost reduction, quick development, and scalability. A key enabler of this transformation is the use of Commercial Off-the-Shelf (COTS) components, particularly from the automotive industry, as a less expensive and scalable alternative to traditional HiRel components.

This essay will first explore France's space strategy, and contrast it with Germany's approach, then analyze New Space supply chain trends.

1 France's space strategy and its place in the European space industry

France has pursued an independent space strategy since the early 1960s, recognizing space as a strategic resource for both civilian and defense applications. The creation of CNES in 1961, under the leadership of Charles de Gaulle, marked the beginning of a national effort to develop independent launch capabilities and reduce reliance on US technology. This initiative laid the foundation for France's dominance in the European space industry, culminating in the launch of the Ariane rocket program in the 1980s. This program provided Europe with independent access to space and became the foundation of European space autonomy. In addition to its leadership in launch vehicle development, France played an important role in the creation of the European Space Agency (ESA) during the 1970s. France has since kept a dominant position in ESA's strategic direction, ensuring that its national interests align with larger European projects. The 2000s saw an expansion in CNES's focus, incorporating dual-use military and commercial space applications. Earth observation, telecommunications, and defense satellites became central to its strategy, strengthening even more France's leadership in space technology.

The French government has recognized for a long time the strategic importance of its defense and aerospace industries, by providing extensive support through funding, policy initiatives, and industrial partnerships. The aerospace sector is a pillar of the French economy, with major players like Airbus, Thales, and Safran receiving consistent government backing. France's approach to aerospace funding combines direct investment, tax incentives, and public-private partnerships to ensure continuous innovation and global competitiveness. One of the most significant forms of support comes through the French defense budget. The French Ministry of Armed Forces allocates substantial resources to space-based defense projects, including reconnaissance satellites, secure communications, and early-warning systems. Programs such as the CSO (Composante Spatiale Optique) reconnaissance satellites and Syracuse military communication satellites illustrate the government's commitment to maintaining strategic autonomy in space-based defense infrastructure. CNES, the national space agency, also plays a key role in advancing aerospace capabilities through research and development initiatives. Government-funded programs, such as the Ariane rocket series, have ensured that Europe remains competitive in the global launch market. The development of Ariane 6, which aims to provide cost-effective launch solutions, demonstrates France's commitment to maintaining leadership in space transportation. Furthermore, France has implemented policies to strengthen its domestic supply chain and reduce dependence on foreign suppliers. The government encourages investment in space technology startups through funding programs such as the France 2030 plan, which allocates billions of euros to innovation in the space sector. The recently launched France Spatial initiative aims to enhance national capabilities in satellite manufacturing, propulsion technology, and space exploration. Collaboration with the European Union and ESA further amplifies France's influence in space policy. By leveraging EU funding mechanisms, France ensures that its aerospace firms remain at the forefront of technological advancements. The government also fosters partnerships with private companies to develop next-generation technologies, including reusable launch systems and miniaturized satellite platforms.

While France has pursued a nationally driven, defense-integrated space strategy, Germany has taken a science-driven, commercial approach. Germany's space program is managed by the Deutsches Zentrum für Luft- und Raumfahrt (DLR), which was founded in 1969 as a merger of multiple research institutions specializing in aeronautics, astronautics, and energy technology. Unlike France, which integrates defense, aerospace, and space industries, Germany's space sector remains more academic and research-oriented, often collaborating with

European partners rather than developing standalone programs. France's leadership in space technology is most evident in the development of the Ariane launch vehicle program. The ArianeGroup has become the preeminent European rocket manufacturer, giving France strategic control over Europe's access to space. In contrast, Germany excels in satellite manufacturing and space robotics. German companies, such as OHB and Airbus Germany, specialize in high-precision satellite systems, but they do not compete directly with France's dominance in launch vehicle technology. Another key distinction is funding. While France has aggressively funded its aerospace and defense sectors, Germany has taken a more conservative approach, emphasizing public-private partnerships rather than direct government control. As a result, Germany's space industry is highly integrated with the broader European market, whereas France maintains more national control over its strategic assets.

France has solidified its leadership in the European space sector through long-term investments, industrial integration, and strategic policy leadership within ESA. The strength of France's aerospace sector, particularly through Airbus, Thales, and Safran, has allowed it to remain competitive in both government-backed and private space projects. Airbus is one of the world's largest aerospace manufacturers, specializing in satellite production, launch systems, and defense applications. The company plays a central role in the development of the Ariane rocket series and is heavily involved in telecommunications, earth observation, and military satellite programs. Additionally, Thales Alenia Space focuses on satellite manufacturing, space exploration, and defense systems. It provides key technologies for ESA missions and supports France's strategic independence in satellite communications and reconnaissance. And finally, specializing in propulsion technology, Safran is a major contributor to the Ariane rocket engines and other key aerospace components. Its expertise in high-performance propulsion systems has been instrumental in maintaining France's leadership in launch vehicle technology.

The extensive government funding that France provides to its space sector allows for rapid technological development, ensuring that French space firms remain at the forefront of the industry.

However, the rise of New Space presents a challenge to this traditional model. Startups and private companies, primarily from the US and China, are pushing for faster, cost-efficient alternatives, which are reshaping the global space industry.

2 New Space trends and Component supply chain

New Space represents a fundamental transformation in the way space missions are conceived, manufactured, and deployed. This shift is driven by the quick commercialization of space technologies, increasing affordability of launches, and the growing demand for global connectivity. Unlike traditional space missions, which were often government-led, slow-moving, and highly specialized, New Space initiatives prioritize speed, cost efficiency, and scalability. Companies now embrace mass production techniques, commercial partnerships, and iterative development cycles to bring space technology closer to the fast-paced world of consumer electronics and automotive manufacturing. One of the defining trends of New Space is the proliferation of Low Earth Orbit (LEO) satellite constellations. Companies such as SpaceX's Starlink, OneWeb, Amazon's Project Kuiper, and China's Guowang are deploying thousands of satellites to create global broadband networks. Unlike traditional geostationary satellites, which operate at altitudes of around 36,000 km and serve a fixed region, LEO satellites orbit much closer to Earth—typically between 300 and 1,200 km. This results in lower latency, higher data transfer rates, and improved resilience through network redundancy. These constellations have dramatically altered the economic landscape of the satellite industry, shifting from single high-value missions to fleets of mass-produced, disposable satellites designed for rapid replacement and technological evolution.

One of the important actor of this transformation is the adoption of Commercial Off-the-Shelf (COTS) components, which has significantly reduced costs and accelerated production timelines. Traditionally, space systems relied on High-Reliability (HiRel) components, which underwent rigorous testing and qualification procedures to ensure operation in extreme conditions, including vacuum, radiation, and temperature fluctuations. These components, however, are extremely expensive, with long lead times and limited suppliers. In contrast, New Space companies are integrating COTS components from industries such as automotive, consumer electronics, and telecommunications. Automotive-grade semiconductors, high-performance computing chips, and even commercial lithium-ion batteries are now being repurposed for space applications. This shift has provided several key benefits, such as significant cost reductions due to mass production in commercial industries (lower component costs compared to traditional space-grade components), quick iteration cycles that allow for fast adoption of new technologies, standardization that facilitates modular satellite design, and faster procurement that enables quick assembly of spacecraft.

The adoption of COTS has led to a fundamental shift in space system design philosophy. Historically, space missions prioritized extreme reliability, as failures in deep-space environments or geostationary orbits could not be easily mitigated. This led to the use of expensive, radiation-hardened components, excessive redundancy, and conservative system designs. HiRel components undergo rigorous qualification processes, including Total Ionizing Dose (TID) testing, Single Event Effect (SEE) mitigation, and outgassing prevention to ensure their functionality in space for decades. A contrario, New Space companies embrace a different risk-management approach, favoring acceptable failure rates rather than over-engineering. Instead of guaranteeing that a single component will function flawlessly for decades, they build systems with built-in redundancy, meaning that if one unit fails, another can take over seamlessly. This methodology is especially useful for LEO constellations, where failed satellites can be deorbited and replaced without major disruptions. Traditional HiRel components are typically found in deep-space missions, government defense applications, and long-term planetary exploration. Their high cost and slow procurement cycles make them less suitable for commercial LEO applications, where cost and deployment speed are critical. However, for New Space missions, cost-effectiveness and iterative upgrades take precedence, allowing for a continuous evolution of technology rather than long-term reliability.

Despite its advantages, the reliance on COTS components also presents significant engineering and reliability challenges. The primary concerns include radiation sensitivity, material compatibility, vacuum suitability and thermal stress. First, unlike HiRel components, automotive-grade electronics are not designed to withstand the intense radiation found in space. This can lead to Single Event Upsets (SEUs), where a charged particle flips a bit in memory, potentially causing data corruption or system malfunctions. Some COTS components require radiation shielding or error-correcting software to mitigate these effects. What's more, many commercial components use lead-free solder, which is prone to tin whisker formation—tiny metal filaments that can short-circuit electronic systems in microgravity. Traditional space components use leaded solder to prevent this, but environmental regulations in commercial industries have led to a phase-out of leaded materials. Furthermore, consumer-grade plastics, adhesives, and circuit board materials may release gases in the vacuum of space, which can contaminate sensitive optical instruments or degrade electronic performance. And finally, space environments expose electronics to extreme temperature cycles and vibrations. Many COTS components require additional thermal management systems or mechanical reinforcements to endure these harsh conditions.

Manufacturers are also adapting by developing hybrid solutions. They recognize the need for a balance between cost efficiency and reliability. One of the solutions is radiation-tolerant COTS. Companies like Infineon and Xilinx have introduced radiation-hardened versions of commercial chips, offering enhanced reliability without the extreme costs of traditional space-grade semiconductors. Another solution is the adaptation of qualification frameworks. In fact, Space agencies such as ESA and NASA are adapting their component qualification processes to accommodate COTS. New standards, like ECSS-Q-ST-60-13C, allow for selective use of commercial components while enforcing testing protocols to verify their performance in space. The last interesting hybrid solution is AI-enhanced fault tolerance. New Space companies are leveraging artificial intelligence to detect anomalies and dynamically reroute tasks in response to component failures, enhancing system resilience without requiring HiRel parts.

The future of the space industry will likely be shaped by deeper collaboration between the aerospace and automotive sectors, as well as continuous advancements in hybrid component technology. The increasing use of automotive-grade semiconductors, AI-powered fault detection, and modular satellite designs suggests that cost-effective space systems will become even more dominant in commercial markets. As AI and machine learning continue to improve, autonomous systems capable of predicting failures and adapting in real time could further enhance mission reliability while keeping costs low. Furthermore, as space-based industries grow - such as in-orbit manufacturing, space tourism, and asteroid mining - the demand for efficient, scalable, and affordable space systems will increase. Governments and private companies alike will need to strike a balance between mission risk and economic feasibility, leading to further refinements in regulatory frameworks that guide the integration of COTS components.
While New Space has already revolutionized access to space, some risks remain. The rapid expansion of satellite constellations raises concerns about space debris, regulatory challenges, and spectrum congestion. Companies and space agencies must address these challenges

through enhanced orbital management, debris mitigation strategies, and responsible deployment practices.

Ultimately, the New Space revolution is unlikely to crash but rather evolve into a more mature industry where cost efficiency, innovation, and sustainability will drive future missions. By leveraging cross-industry collaboration with automotive and AI-driven innovations, the space industry can ensure long-term growth while expanding humanity's capabilities beyond Earth.